MY FIR LADY

The New Brunswick Production With Its Facts and Fancies

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A little over thirty-one years ago in 1951 a decision was taken by a pulp and paper company and the province of New Brunswick to attempt to forestall losses from the spruce budworm by aerial application of insecticide. The target of the operation was to be an almost unbroken 300 square mile tract of prime fir-spruce forest under lease to the company on the Upsalquitch watershed of the northeastern highlands of the province. The tract represented only a small fraction of such forest in the province and of the then burgeoning outbreak. But it had been one of the first areas attacked and had by then undergone three years of severe defoliation. The judgment of federal scientists was that the province appeared to be in for another full-scale budworm outbreak, on schedule, and that the natural result would be almost certain decimation of mature stands such as those on the company leasehold. They agreed that the damage would probably outstrip the industry's capacity for salvage and that the only possibility of forestalling catastrophic losses might be the use of insecticides.

Deliberations leading to this decision had actually commenced a year previously, in 1950, and had drawn exhaustively upon all expert knowledge, opinion and experience then existing in Canada and the United States. The budworm had been under scientific observation in New Brunswick since the previous outbreak, 1910-1920, and became the subject of intensive federal research projects in Ontario and New Brunswick in the 1940s. Quick advantage had been taken of the World War II development of DDT to experiment with aerial applications against the spruce budworm in both countries as early as 1944. Ontario conducted operations totalling nearly 100,000 acres in 1945, 1946, taking particular care to have unwanted side-effects investigated by multi-disciplinary teams of experts. In 1949 operations were commenced in the US Northwest that were to approach nearly a million acres a year for several years.

The New Brunswick operation of 1952 was meticulously planned to take the best advantage of this background. The Forest Insect Investigations Unit of Science Service, Agriculture Canada, undertook to provide scientific services from its Ottawa, Sault Ste. Marie and Fredericton establishments, under J.J. DeGryse, M.L. Prebble and R.E. Balch respectively. K.R. Elliott was seconded from Sault Ste. Marie as liaison officer for spray technology and deposit assessment and F.E. Webb was appointed from the Fredericton Laboratory to take charge of biological surveys, timing of application and assessment of results. The embryonic Chemical Control Research Institute was conducting spray technology research in central Canada under J.J. Fettes and played a peripheral advisory role. B.W. Flieger directed the operation on behalf of its sponsors assisted by such indestructable veterans as B.A. (Bev) McDougall. By universal agreement experienced technologists and scientists of the

USDA, most prominently D.A. Isler and W.E. Waters, were invited to take an active part, to the considerable advantage of the project. A.W.A. Brown, then emerging as one of Canada's most perceptive and articulate experts on insecticide usage, was engaged by Flieger to observe the operation and made certain investigations of effects on non-target insects. Canadian wildlife and fisheries agencies were urged to monitor side-effects on birds, mammals, and aquatic organisms.

In short and contrary to some latter-day notions the 1952 spray operation may yet stand as the most carefully deliberated, most meticulously planned and most carefully observed forest spraying operation yet to occur. It was in this atmosphere that the federal entomologist-on-the-spot finally gave the signal to commence spraying the following morning, June 14. Whether he saw any ill-omen in the fact the decision day was a Friday the 13th is lost to memory; in any case that action kicked off one of the boldest ventures yet attempted in eastern Canadian forest management as well as one of the most controversial, poorly understood, misrepresented and universally unloved ones.

No other eastern province is more dependant on its forest industry or is closer to facing critical wood shortages. No other jurisdiction's forests are composed of a higher proportion of budworm-susceptible types or has been subject to more persistent budworm attack in the past three decades. No other jurisdiction is working harder at correcting an unbalanced age-structure that may be part of the biological problem, or at implementing silvicultural measures aimed, hopefully, at mitigating the problem in the future. And no other province has committed more supplementary funding to the traditional federal mandate to seek alternatives to the use of insecticides and of going about spraying in the most efficient, efficacious and safest ways.

In short, managing the budworm problem is a peculiarly compelling problem in New Brunswick. The most obvious reflection of this is its record of carrying out the longest-running and sometimes the largest forest spraying operations in the world. Not surprisingly this sort of record has attracted some of the most avid attention of critics, not only those acting out of concern for possibly serious effects on the forest environment and public health, but also forestry theorists unconvinced that such blunt-nosed approaches are necessary or wise in either the short or long term.

Each of these positions deserves respect. The largely intuitive conviction of the industry and a succession of provincial governments up to 1976 that any other course than spraying would be economically unthinkable and would amount to relegating the forest management role to the budworm has been convincingly backed-up by more elegant forms of analysis developed in recent years and for which Baskerville has become a chief spokesman. Interventions on this scale in complex ecological systems demand the most careful analysis possible of short-term effects and a persistent watch for later-appearing ones. New Brunswick governments have repeatedly stated that significant threats to public health will be regarded as intolerable and sufficient reason to terminate spraying forthwith. And surely there must be formulae for managing the budworm problem in which chemicals play a less prominent role.

New Brunswick forest management and forest spraying authorities have consistently attempted to deal with environmental concerns with careful respect. Until the late 1960s Forest Protection Limited remained the chief instigator of regular reviews of environmental concerns at the provincial level and has remained a substantially involved participant since the leadership of such reviews was taken over by Environment Canada, the University of New Brunswick and Environment New Brunswick in turn. The company has regularly contributed in various ways to many monitoring projects of other agencies and along with the province's Department of Natural Resources fostered the development of a provincial centre of competence in spray accountancy at the Université de Moncton. The Department of Natural Resources contributed a substantial share of the province's support of Reye's Syndrome research at Dalhousie University.

However well justified the spray program can be shown to be, however clear the evidence may be that it has substantially achieved its intended objective, and however difficult it has proved to be to find serious environmental perturbations and health risks the popular image has consistently been something else. Among the more familiar facts and fancies are: that eradication and outbreak control were the first objectives, that this has been an obvious failure and claims of an original tree protection policy are now simply cover-up revisionist history; the history of infestation and spraying are stubbornly claimed to have followed a pattern that is far from factual; biological control systems are dogmatically claimed to have been destroyed however little evidence of this can be found; chemically-resistant budworms, although yet to be found, account for New Brunswick's persistent infestation; New Brunswick springs are supposed to be silent without any evidence that the music-makers are any less abundant or musical; damage had occurred to public health up to and including the killing of children although no evidence in support of this can be found by blue-ribbon international medical task forces; "good forest management" is a viable alternative to spraying here and now although no one seems to know or cares to explain how to go about it in the budworm context. The list goes on.

Distorted public images in such emotionally-sensitive areas as the environment and public health have, of course, become a commonplace phenomenon. This is readily enough understood in that predominant part of the lay public that depends for its information on media that are too often inexacting, sensation seeking, or as with the CBC, promoting an anti-establishment environmental prejudice of its own. Add to this a strident anti-spray lobby and the picture is almost complete. Almost that is, but not entirely. For it is a less-understandable and often more frustrating fact that serious misunderstandings, misconceptions and committed mind-sets critical of the New Brunswick approach are prevalent in more technically-educated and purportedly scientifically-oriented circles as well. This does not infer that New Brunswick managers would prefer all minds to be set in favor of the program - far from it. What is truly wanted is the most informed debate possible on the subject within those elements of society best equipped to arrive at commonsense judgments of the matter and to help find a more acceptable solution. That is not likely to come to pass in a situation in which it is seldom possible, as we have repeatedly discovered, to commence a dialogue about

the management of the New Brunswick problem with renewable resource biologists and scientists who are not closely involved, even entomologists and foresters, without quickly encountering some misconception or other about it. The problem becomes exacerbated when misconception becomes installed in the permanent scientific literature, as in fact has already become the case. To take an example in a field of science in which standards of scientific publication might be expected to be especially exacting, consider the fact that the Dalhousie University Reye's Syndrome research team have regularly informed their peers around the world, in effect, that New Brunswick budworm sprayers makes no discrimination between habited, nonforested areas and budworm-infested forests. It is simply not possible to understand from their scientific publications that exposure in habited areas can only be from off-target drift usually over several kilometers and then only when meteorological situations permit. This does not, of course, totally invalidate their experimental hypothesis, but it does put a significantly different dimension on one of its key assumptions - a point that, although it has been drawn to their attention, the authors have made no effort to revise in subsequent publication. A very recent example exemplifies this and retails yet another piece of nonsense. It is from a paper by K.R. Rozee et al. published in the Canadian Medical Association Journal, April 1, 1982, updating research suggesting a link between experiments with animal models and Reye's Syndrome in children.

> "In Atlantic Canada the distribution of cases of Reye's Syndrome has in previous years been found to coincide geographically with forested areas that have been sprayed every growing season since 1952 with pesticides to suppress the spruce budworm that infests the coniferous forests of that region. The populace of neighbouring unsprayed forests had, and still has, a significantly lower incidence of this syndrome than the populace of the sprayed area."

So not only has the myth of a human populace domiciled in sprayed areas been repeated, medical science has now been advised, purportedly through a scientific peer review system, that there are areas in New Brunswick that have been sprayed every growing season since 1952. In fact very little area is resprayed in as few as one or two successive years and no area has been treated in more than a fraction of the total years of the program.

Keeping the facts straight on the Reye's Syndrome hypothesis obviously poses a particular problem, afflicted as it seems to be with a determined unwillingness of the Dalhousie team and indeed in others in the public health and toxicology fields to establish mutually helpful communication links with managers and scientists addressing the spray programs their hypotheses implicate. Fortunately, more rational interfacing with medical science occurs in some other jurisdictions and provides some hope that the difficulties that have characterized the New Brunswick situation will become resolved in time. However, the effort to bring this about will obviously have to continue to come chiefly from the perpetrators of spraying, namely the resource management side.

As indicated earlier, budworm spraying commenced in New Brunswick as a closely integrated team effort by the provincial and federal governments and industry. It was a problem whose time had come and, in fact, had been foreseen by such actions as the organization of "The Green River Project" in 1945 for the purpose of studying the potential of forest management in the control of the spruce budworm. Through agreements with the then Department of Lands and Mines and Fraser Cos. Ltd., research facilities were provided and experimental areas in northwestern New Brunswick were set aside for the purposes of research and experimental trials by entomologists of Science Service, Agriculture Canada, and silviculturists of the Dominion Forestry Service. As on the N.B. International Paper Company's Upsalquitch limits, much of the research area became severely infested by the turn of the decade and precluded much of the silvicultural experimentation that had been intended . The entomological team, on the other hand, under the leadership of R.F. Morris established a series of research plots and a life table methodology in time to follow the dynamics of budworm population behavior throughout the rise and fall of the 1950s outbreak. Published in 1963 as Memoir 31 of the Emtomological Society of Canada that work continues to be regarded as some of the most important fundamental research yet conducted on the spruce budworm and the plot records as one of the most valuable data banks for continuing analysis. As a natural course of events, Morris became drawn into the early deliberations of the New Brunswick spray proposal but along with his principals in Fredericton and Ottawa was reluctant to have resources devoted to the fundamental Green River research diverted to servicing the needs of the probably temporary spray project. Chiefly for this reason, the pattern was established of providing research and advisory services to the spraying program as a separate project of the Fredericton Laboratory identified, for convenience, as the Upsalquitch Project. Webb was then winding up his post-graduate work in Michigan and was assigned as project leader. D.R. Macdonald, having had some budworm experience under Fettes in Ontario was transferred from Sault Ste. Marie to assist.

The job was approached on two fronts. Because of the growing interest in spraying it was decided to set up a series of permanent plots in sprayed and control areas for assessing both immediate and long-term results. Data were gathered following Green River methodology to ensure compatability. Effects on growth and survival were measured on these and additional plots. Macdonald undertook a study of effects on budworm parasites and comparisons were made of pre- and post-spray populations of fish food organisms in sprayed and unsprayed streams. In 1953 an additional plot system was established on the Tobique.

The effort was not wasted. Although commonly referred to as the Green River Monograph, Memoir 31 is actually an analysis of data collated from sprayed and unsprayed areas on the Upsalquitch and Tobique with the more intensive records of the Green River plots, thereby adding an analytical dimension not foreseen in the original Green River experimental design but ultimately highly relevant to the budworm management question (Webb 1958; 1963).

The foremost purpose of the so-called Upsalquitch project, however, was to provide the immediate biological information required to

conduct the spray program. It quickly became evident that new investigative methodologies would have to be developed. These would have to be a compromise between the meticulously intensive methods of the Green River project and the relatively un-intensive methods of the Forest Biology Division's Forest Insect Survey. It also promptly became evident that such development work would require substantial material assistance from the spray program's management. For example virtually all observation aircraft time required by the federal assessment teams has been provided by the spray proponents since the inception of spraying and increasingly over the years so has the casual manpower and other facilities required for ground surveys and related R&D. Since 1976 staff seconded to the Maritimes Forest Research Centre has included professionally trained foresters and entomologists.

Almost the first need to become evident was a streamlined system of measuring egg mass populations in sprayed and unsprayed areas. This was considered essential for assessing results of spraying and, more importantly, for forecasting infestation to be expected the following year from the rapidly expanding outbreak - from 160,000 hectares in 1951 to ½ million in 1952 and nearly 2 million in 1953. Using relatively limited 1952 egg counts collected from sprayed and check areas R.F. Morris devised probably the first insect egg counting system designed on the sequential principle (Morris 1954). Employed in 1953 and 1954 his table was then recalculated by Webb from the much larger body of data then available, employing a revised defoliation/population regression, to produce the two- and three-class formats since employed in the Atlantic provinces, Maine (Webb et al., 1956) and elsewhere. By then it had also become evident that evaluating the need for spraying as a foliage preservation - tree protection exercise required relatively sensitive evaluation of existing tree condition along with the forecasts of defoliation to come. To answer this more comprehensive need the revised egg sampling system was combined with estimates of three indicators of tree condition: current and earlier defoliation and indications, if any, of growth recovery. Each of these was attributed weighted values and the total summed to provide a scale of composite values representing the probable hazard to tree survival and growth without protection (Webb et al., ibid.). Yet to be correctly reported and referenced in the formal literature, this model, with some modification by E.G. Kettela and others, has remained in standard use in the Atlantic provinces and Maine.

In terms of designing forest protection programs the influence of this particular piece of methodology has obviously been very substantial indeed. What might be less appreciated, however, is the fact that as a shared-cost product of the spray program it also has produced a large and critically important part of the New Brunswick spruce budworm data bank so admired by resource management modellers around the world. Used together with the Memoir 31 research it has been the driving component of the Holling et al. modelling employed by Baskerville e.g. in his evaluation of the budworm management problem for the New Brunswick government in 1976 (Baskerville 1976).

Students of spruce budworm management do not need to be told that organization of budworm spraying programs has been as jurisdiction-specific as is the budworm problem itself. Having the longest history,

the New Brunswick model probably has set as many precedents as any other and has become in need of overhaul as often as any. For most of its history, budworm spraying was about all there was to budworm management in New Brunswick apart from expediency-oriented harvesting to keep ahead of losses impossible to forestall by spraying alone. This might not have been the case if, as detractors claim, the history of infestation in New Brunswick in the past 30 years had been one of persistent enlargement and intensity. In fact it has been a history of extraordinary and unprecedented erraticism, apparently involving two and possibly three outbreaks within a three to four decade period. The record of spraying has fluctuated accordingly.

The first of these outbreaks lasted a decade, collapsing in New Brunswick and its neighbors in 1958-59, on schedule according to conventional expectation, and in spite of extensive spraying and the preservation of vast areas of highly susceptible and vulnerable forest. The crisis in New Brunswick seemed over, environmental concern abated and along with it some of the steam that had begun to generate for a more definitive provincial budworm management policy.

Unlike the first phase, in which infestation spread almost over the entire province, 1960 to 1968 presented a pattern of relatively small, discontinuous hotspots shifting around central areas of the province. It was an unprecedented pattern for which forest scientists could offer little explanation especially as it persisted in forest types that did not fit the classic concept of susceptibility. Projected losses even without spraying did not reach the crisis proportions of the 1950s and did not rekindle the same pressures for a more definitive long-term budworm management policy. Forest Protection Limited which had been formed as a coalition of government and industry following the 1952 operation, and mothballed in 1959, was reactivated in 1960. Because of the patchiness of infestation and hazard the conservative criteria for defining areas for spraying became necessarily relaxed to include stands in which although insect numbers might be high the likelihood of imminent tree killing might not. In effect this resulted in a shift in policy from strict tree protection to modified population control. An occasional practice was also followed of spraying an extra buffer along the northern fringe of sprayed areas in an attempt to discourage reinfestation of the highly susceptible northern forests. Assessments of these forms of spraying provided no conclusive evidence of their effectiveness, however.

By 1969 a third phase was clearly developing, not in New Brunswick alone, but in neighboring jurisdictions as well. By 1975 infestation of unprecedented ferocity and extent had arisen on over 60 million hectares from the Great Lakes to Newfoundland. Large-scale spraying following the foliage protection/tree preservation policy recommenced in 1969 and has continued since. As the need for protection continued to rise in the early 1970s, limited budgets encouraged attempts to maximize coverage through such measures as cutting insecticide dosage below that permitted under registration. A combination of unfavorable spraying weather and extremely virulent infestation in 1975 demonstrated the risk of such tactics and resulted in the need in 1976 for the largest program ever - 3.9 million hectares representing 3/4 of the total forest area. Concerns about this kind of escalation in the climate of the

Reye's Syndrome issue resulted in a government decision in 1977 requiring that spray not be emitted by Forest Protection Limited aircraft closer than one mile from year-round habitations. The immediate effect of this was to remove over 90% of small forest ownerships and woodlots from protection, representing one-third of the total provincial forest. On the basis of drift models commissioned by the New Brunswick Department of Health, and Forest Protection Limited, this constraint was reduced to 1000 feet in 1981 subject to the use of agricultural type aircraft and certain other constraints. However the imposed four-year moratorium had resulted in such extensive killing in much of the setback area that the net effect of this for some years to come may be simply to permit the protection of younger growing stocks. Despite the setback exclusion, however, programs of about 1.6 million hectares have been required annually since 1977.

As in the previous phases, the behavior of the 1970 - early 1980s outbreak, and research during this period, have provided additional challenges to conventional beliefs by no means in New Brunswick alone. The budworm is clearly not the respecter of the younger age classes of its hosts it once was believed to be - opening the question as to the supposed silvicultural effectiveness of controlling the extent of mature and overmature classes. The hackneyed reference to balsam fir as the budworm's "preferred" host has no scientific corroboration; it may in fact be less "preferred" than one or two other species even if it succumbs sooner to budworm attack - again points of distinction important in the silvicultural context. The years-long search for outbreak epicentres in classically susceptible/vulnerable fir-spruce forests was probably misdirected - hardwood/white spruce types may be a more likely possibility. Red spruce may be a better budworm nursery than has been suspected and may be the most vulnerable to killing next to fir. Black spruce can be seriously affected and often killed by the budworm; stands of this species planted in good sites may not be as discouraging to the budworm as had been widely surmised.

1975 became an historical watershed for several reasons. Forest Protection Limited came under new managership with renewed determination to achieve more efficient, effective and safer spraying through improved spray technology. As demands on the traditional resources of the Forest Pest Management Institute of the Canadian Forestry Service were then beyond its capacity to handle in full, a program of supplementary research and development directed specifically to New Brunswick needs was commenced by the company. This need was reinforced in 1976 by a regulatory requirement to provide data on the extent of off-target drift. The state of the art in drift research was examined by a task force under I.W. Varty which made a number of recommendations that have since been followed. A provincial center of competence in drift and spray technology has developed at the University of New Brunswick; important mass-balance research and drift modelling have been undertaken in the province by the National Research Council. The province's Research and Productivity Council has also developed wide competence in spray delivery technology and has organized the New Brunswick Spray Efficacy Research Group to facilitate coordination of New Brunswick-focussed projects. Again, some misconceptions and surprising gaps in knowledge have been uncovered.

On-target spray deposits are more likely in turbulent air than under inversions; spraying under the latter conventionally favored conditions appears to give the greatest guarantee of long-distance, off-target drift. Elementary features of larval behavior essential to an elucidation of the pathways of toxicity are little known, as is the logical target at which to aim droplets. The most effective droplet spectra for specific insecticides remain a matter of considerable debate and an adequately sensitive and practical means of measuring effective deposit has yet to be developed.

1975 also marked a turning point in the approach of the New Brunswick Department of Natural Resources. As the chief shareholder in Forest Protection Limited the department up to that point had left the management of the protection program almost entirely in the company's hands. It had likewise relied totally upon the Canadian Forestry Service for scientific and technical advisory services. As a result departmental staff below the Assistant Deputy Minister level were virtually uninvolved in budworm management. Until today's date it has had the distinction of being the only such provincial department in Canada without a forest entomologist. The gravity of the budworm threat from the 1970s outbreak, together with mounting indications of wood supply problems and escalating anti-spray sentiment clearly demanded a reorganization of the department's role. Steps were taken to provide greater headquarters and regional staff involvement in designing spray operations. Through the DREE Forestry Agreement, substantial funding was allocated to research on alternatives to spraying at the University of New Brunswick under departmental steering committees. Similar funding was used to develop interest and investigative competence in the budworm problem at the Research and Productivity Council, Mount Allison University and among private-enterprise consultants. In 1976 G.L. Baskerville was engaged to conduct an evaluation of the status of the budworm problem and alternatives for its management. Modern modelling techniques were introduced to analyse the implications of the budworm problem in supply/demand projections. Thus, though still not fully resolved, the nature of institutional responsibilities and accountabilities for managing the budworm problem have undergone a major overhaul in the past 8 years and the province is a good deal closer to defining its first comprehensive budworm management strategy.

In the light of the importance claimed for New Brunswick's budworm threat, and the stubbornness and cost (not quite 122 million non-indexed dollars including 1982) devoted to holding it off, it must surprise and perhaps worry some that even yet a definitive strategy to deal with it is not quite in place. From the vantage point that we, the authors, have had the reasons are complex and include many of the usual ones afflicting ponderous bureaucratic systems, especially multi-jurisdictional ones. But more significant in the long term and by-and-large the more important still to be resolved are some of the more philosophical ones. Fittingly enough as a conclusion to this paper they involve what we believe to be misconceptions.

Before it can be managed it is necessary to recognize just what the budworm problem really is. The conventional impression is that it is basically a problem of dealing with a forest insect threatening a forest resource. The first corollary to that is that its solution is a matter of controlling the insect. The second is that it is primarily a job for

entomologists. We disagree and will argue that the best and most logical management strategy cannot be devised on that philosophical approach. We believe it to be a mind-set that has historically misdirected responsibility and accountability for the problem's management, certainly in New Brunswick.

Our postulate is that the essence of the problem is how to maintain a healthy, productive forest in the face of an insect pest threat. The bottom line to budworm spraying is the control of insect damage, not of insects.

Historically, the emphasis has tended to go in the reverse direction: that the preoccupation should first be with controlling the insect and that tree protection would follow in a logical sequence of events. By and large entomologists have tended to accept this reasoning and the challenge it represented. By and large silviculturists and other management-oriented foresters have been overly content with this rationalization and the notion of a disciplinary mystique about the budworm that would best be left with entomologists. The result has produced a large imbalance of knowledge and competence among the broad disciplinary areas that become involved in protection by spraying. While the entomology of the budworm is far from completely understood, more is known about it than any other forest insect in the world. Sprayers have demonstrated a capability to achieve a reasonably satisfactory result at a reasonable cost, and considerable R&D has been mounted to achieve more efficient, efficacious and safe results. But the area in which knowledge is most limited, the methodologies for assessment weakest, and protection judgments still closest to being intuition and guesswork is a knowledge of the state and health of the forest itself and how to measure this for evaluating the need for protection. It is a situation that has tended to creep up on forest managers; because of the effects of persistent budworm activity, erratic protection strategies and budgets, and very extensive harvesting dictated all too often by budworm activity, budworm management in New Brunswick in 1982 is a far more complex and puzzling challenge than it was in 1952.

If the thrust of this paper has left an impression that forest sprayers in New Brunswick like the insecticide approach any more than most, that too would be a misconception. As the world has unfolded, being involved with it can be a singularly unrewarding and unpopular occupation. We do have confidence that, on the balance, the New Brunswick spray program has accomplished results that are substantially more in the public interest than against it and deserve reasonable public and intellectual support because of this. By the same token, no spray-involved person of our acquaintance considers conventional budworm spraying alone to be anything like a satisfactory and ultimately tolerable way of managing the problem. It is simply too blunt-edged and environmentally insensitive. IPM is anything but a new concept in North American forestry and does not strike us as offering much enlightenment to those, e.g., who have been wrestling hand to hand and intellectually with the New Brunswick budworm dilemma for these 30-odd years. But if dusting it off will help keep others less close to the subject aware that there should be more enlightened approaches and that these should be kept in the investigative shopping basket, we are all for it.

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